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The Development Of New And Improved Uses For Surplus Crops [1]

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It is a pleasure to join with you on this occasion in the consideration of some of the agricultural problems of the American Republics.

One of the subjects that has caused discussion in nearly all of these countries in the last few years is what to do with the surplus crops. The profitable utilization of surplus farm products is one of the most important problems in our whole agricultural field. Many people feel that it holds the answer to some of our most perplexing farm questions.

It may seem strange to some of you for me to be talking about surpluses at a time when we are stressing the increased production of many of our most important crops. But we are at war, and in times of war it is nearly always necessary to increase the production of food and feed crops. When the exceptional wartime demands have diminished, as some day they will, many of the countries that are represented here will again be faced with burdensome surpluses of certain farm crops and commodities. I might add that even during the present world wide war, we still have surpluses of a few of our major crops, but the real difficulty will come in the years when the world is trying to get back to normal conditions. So it is our job as scientists and administrators to look ahead to post-war days and try now to lay plans that will help to prevent the return of such chaotic conditions as those we experienced in the early twenties, following the first World War, and which were repeated on a larger scale in the early thirties.

A great many people feel that one of the ways to meet this situation is to turn these surplus crops, or as many of them as possible, into industrial products instead of trying to crowd them into the rather limited human stomach. We know, of course, that certain agricultural commodities can only be used as food, but there are others which can be produced on a large scale and at a reasonable cost which could be used by industry if a suitable and profitable outlet could be found. One of the important jobs of the U. S. Department of Agriculture is to discover such outlets and bring them to the attention of those in a position to make use of them.

The development of new and improved uses for agricultural products is not a new problem for the United States Department of Agriculture. As long ago as 1908, an exhaustive study was made on the production of industrial alcohol from various farm materials, and in 1911, a project on the production of paper from agricultural residues was given extensive consideration. Both of these investigations, while successful in establishing the possibility of the utilization of farm crops in industry, also succeeded in demonstrating definitely what is so frequently the case with agricultural raw materials, namely, that the economics of the situated were unfavorable in that the same final products were being produced as well, and more cheaply, from other raw materials.

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Following the Department's work on the utilization of agricultural raw materials which I have just mentioned, similar work was carried on more or less continuously in various agencies of the Department in Washington, especially the Bureau of Agricultural Chemistry and Engineering and its predecessor organizations. In the meantime, field laboratories had been established at several places for the study of various commodities. The first of these was an industrial laboratory for the work on citrus products. It was established in Los Angeles, California, in 1914 to investigate the possibility of the utilization of the surplus and culls of the citrus crops of that area. A representative of the Bureau of Chemistry was sent to Europe to study the production of citric acid, lemon oil, and other byproducts of the citrus industry, and he was able to establish an industry in the United States for the production of these citrus byproducts, which is operating successfully at the present day. Another laboratory of great importance was the Agricultural Byproducts Laboratory, established at Ames, Iowa, in 1931 and devoted to the development of new uses for agricultural residues, such as cornstalks, straw, bagasse, etc. This is now a part of the new Northern Regional Research Laboratory at Peoria, Illinois. Then there is the Regional Soybean Industrial Products Laboratory, which was established in 1936 to develop new industrial uses for soybeans. The soybean, which was introduced into the United States about 1900, is a crop of ever-increasing importance for the production of both protein and oil. Up to 1936, the main uses for the protein have been cattle feed, and for the oil in various types of food oils. It was recognized that a wider distribution of soybean products was necessary, and so the Soybean Laboratory was set up at Urbana, Illinois, for this purpose. In the six years of its existence, it has pioneered the way, among other things, in the use of soybean oil in paints and varnishes, and in the use of protein in plastics and fibers.

In 1938 the big development started. In that year the United States Congress authorized the appropriation of four million dollars, for the establishment of four laboratories, one in each of the main agricultural producing areas of the United States. The Act providing for these laboratories states,

> "The Secretary (of Agriculture) is hereby authorized and directed to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and at such laboratories, to conduct researches into and to develop new scientific, chemical, and technical uses and new and extended markets and

> outlets for farm commodities and products and by-products thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or seasonal surpluses, and their products and by-products."

These four Regional Laboratories have been working in the field of new and improved uses for surplus crops for more than a year. Much has been accomplished in this short time, and more is on the way. The greater part of the balance of my talk will be devoted to the discussion of the establishment, organization and program of these Laboratories, for in their work and eventual success lies the greatest hope for the solution of the problem of agricultural surpluses.

The Regional Research Laboratories are located at Peoria, Illinois; New Orleans, Louisiana; Philadelphia, Pennsylvania;and near San Francisco, California, and are named for the four cardinal points of the compass, serving as they do the agricultural producing areas in the Northern, Southern, Eastern and Western parts of the United States. Following their location, surplus commodities were assigned to the Laboratories for research and the development of industrial uses based on these commodities. In some cases, because of the importance of certain crops in widely separated parts of the United States, it seemed advisable to assign the same crop for investigation to more than one Laboratory. That was done in the case of several commodities, as will be obvious from the following list showing the commodities to be studied in each of the four Laboratories:

Northern
- Corn
- Wheat
- Agricultural Residues

Southern
- Cotton
- Sweetpotatoes
- Peanuts

Eastern
- Tobacco
- Apples
- Irish potatoes
- Milk products
- Vegetables
- Tanning materials, hides, skins and leather
- Animal fats and oils

Western
- Fruits
- Apples
- Irish potatoes
- Wheat
- Alfalfa
- Poultry products and by-products
- Vegetables

These commodities fall into two general classes, those which by reason of their strongly individual characteristics may be considered as natural units for research, and may be approached from that standpoint; and those which by reason of their basic composition do not differ greatly from commodities assigned to other laboratories. The first class includes such materials as cotton, agricultural residues, and tobacco; while in the second class we have the commodities in which oil, protein or carbohydrates are the principal constituents. After all, from a broad chemical standpoint, starch enters into similar fields of industrial use, whether it be found in the cereal grains or in the tubers. The same can be said for the oils of cottonseed and peanuts, and the proteins of corn and wheat.

Commodities in the first class are being handled as independent research investigations by the Laboratory to which they were assigned. In the case of those commodities containing common constituents, an attempt has been made to allocate a leading part in the research on each such constituent to one of the Laboratories, the balance of the research on the commodity as such to go to the Laboratory designated to receive it. For example, by a glance at the list of commodities, it can be seen that we have a protein problem in all Laboratories--with casein and the other milk proteins in the Eastern Laboratory; corn protein in the Northern Laboratory; the keratins in the Western Laboratory; and the proteins of cottonseed and peanuts in the Southern Laboratory. The basic leadership in protein work has been assigned to the Eastern Laboratory, with the other Laboratories giving attention to the uses of the particular protein components of the commodities assigned to them. A similar division of work has been attempted for all other fields of work for which coordination was needed.

Ground was broken for the establishment of all four Laboratories at the chosen sites in June, 1939. They were occupied between August 1940 and April 1941. Much of the funds allotted for the Laboratories was used in equipment during the first year of their operation, and it is only now that the full personnel assigned to these Laboratories is being put to work.

All four Laboratories are uniform in design, consisting of a U-shaped building of three stories and a basement. Offices, library and conference rooms occupy approximately the 210 foot base of the U which forms the building. One of the wings, which are approximately 300 feet long, is devoted entirely to laboratories, and the other is intended to house pilot-plant operations. The pilot plant aspect of the work is especially interesting and somewhat unique in government research. Many valuable industrial processes have been developed from research work conducted in Governmental laboratories, but with a few exceptions they have been presented to industry in the form of chemical data based on results from the test-tube and the beaker. There is a vast difference between the technical value of laboratory work performed in glassware with laboratory techniques and laboratory materials, and that done in a pilot plant complete with cost data, industrial raw materials, full-sized specifications, and employing factory technique. It is in development of full scale technical processes that the chief value of the Regional Research Laboratories will lie. The fact that one-third of the space in each Regional Laboratory building is to be devoted to the pilot-plant operations illustrates the importance we place on this phase of the research.

Even though the active operating life of the Regional Laboratories has been short when one considers the time which is ordinarily needed to complete a research project, the progress made has been great in all four Laboratories. The necessity for wartime research has greatly stimulated their efforts. Long before the attack on Pearl Harbor, the Laboratories had shifted the emphasis of their research with a view to concentrating on those projects which were of importance in the national emergency and to laying aside or minimizing those requiring years for their completion. It was felt that in a period of emergency, only those studies which gave some reasonable promise of fulfillment in time to be of service to the nation in its extremity should be given primary consideration, and that other projects of long duration should be placed in the background, to be brought forward again when the time seems suitable. Time and space will not permit me to discuss all of the 74 projects that are now under way in the four Regional Laboratories, but I will give you a very brief discussion about a few of these, along with the slides, in order that you may get a clearer picture of the work we are trying to do in finding new and wider outlets and markets for agricultural products, particularly the surplus crops.

Motor Fuels

The possibility of the utilization of surplus crops in the production of motor fuels offers one of the most attractive outlets for agricultural raw materials. One of the main reasons for this is that such a use would result in the utilization of these materials in very large quantities. It has been estimated that if we were to substitute one-tenth of the total gasoline normally used in the United States by some form of agricultural motor fuel, we would have an outlet for our crops which could only be met by requisitioning a large part of the normal production of one of our more important crops, such as corn. The logical sequel to this statement is that it would be possible to grow carbohydrate crops exclusively for the production of motor fuels, assuming, of course, that there would be a market for the byproducts of the motor fuel production, and assuming also that these crops could be raised at a price which would make a suitable return to the farmer. In considering motor fuels, we must consider anything that will burn; it may be ethyl alcohol; it may be butyl alcohol; it may be the gases which are given off by the destructive distillation of agricultural residues, such as corn stalks, wheat, straw, etc.

The Northern Regional Research Laboratory at Peoria, Illinois, is equipped with a pilot plant designed especially for the experimental production of agricultural motor fuels. This plant has a capacity of 500 gallons per day, and is capable of the production of these fuels from the cereal crops, the tubers, or from any other source of carbohydrate-bearing raw material. It can also be used for the fermentation of the so-called wood sugars produced by the saccharification of agricultural residues. The time may come some day when we shall see a large part of our motor traffic propelled by fuels from renewable raw materials-- materials which may be produced from year to year instead of being drawn from natural sources which have required millions of years for their development.

Plastics

One of the coming industries of the future is the production of synthetic resins or plastics. Most of the materials now entering this field have been produced from other than agricultural sources. Plastics such as those of the bakelite type, the glyptol type, the vinyl type, are derived by the utilization of coal, petroleum and natural gas. With the development of the present war, plastics of the first-named type have been reserved for essential uses in war industries, and a great shortage has resulted. This is agriculture's opportunity. Plastics can be made from any protein or from the lignin which is found as a normal and plentiful constituent of all agricultural residues. These plastics have been known for some time, but their characteristics and cost have been such as to place them outside of consideration for normal uses. Now, with the demand for a great variety of materials to replace those restricted for normal uses, the necessary improvement of the agricultural plastic, from the point of view of both cost and characteristics, may be expected to come from the intensified research being devoted to this problem.

Another phase of the plastic work is the production of the synthetic fiber. The so-called artificial wool, or lanital, produced from casein is a good example of this type of material. But there is no assurance that casein is the best type of raw material for the production of synthetic fibers. Casein happened to be the most available and the purest industrial protein at the time this problem was first given consideration, but there is every reason to believe that similar fibers may be produced from the purified protein found in most of our oil-bearing crops. The superior synthetic fiber of the future may be derived from the protein of the peanut or the cottonseed. Research alone will tell.

Synthetic Rubber

As everyone knows, one of the greatest problems of the present war is the assurance to the United Nations of sufficient supplies of rubber to carry on our war effort. There have been a number of phrases used to describe this war, but it is possible that when it is over, the "War of Rubber" may be as good a name as any. When the situation is analyzed, there is hardly a phase of modern war into which rubber does not enter. It is needed for the airplane, the tank, the battleship, and so on down the line, not forgetting the rubber that is necessary for the tires of the farmer who must bring the country's supply of food to the marketing centers. It avails us nothing to have rubber for the airplane tires if we are unable to bring the manufacturing labor to the airplane factory. Nor can the country exist unless the system for the distribution of food can operate with some degree of regularity.

Synthetic rubber can be produced from agricultural raw materials. The basis for its production is butadiene, and butadiene can in turn be produced from ethyl alcohol, butyl alcohol, or butylene glycol. All three of these materials are producible from the carbohydrate crops, and butylene glycol, which is the newest of the three, is being given intensive consideration as offering the greatest promise. In addition to this, it is possible to produce rubber extenders from vegetable oils by a new process developed in one of the Regional Laboratories, and there is every evidence that the material so formed will be of great importance in the rubber industry. Our experience up to the present time has shown that a certain amount of natural rubber is necessary in the manufacture of all rubber articles. For the completion of our rubber effort, we shall need all of the natural rubber available, from the Hevea of South America to the guayule and cryptostegia of Mexico. It is only by the coordination of all sources of production that our effort can be successful.

Dehydrated Vegetables

When the Axis took possession of the Malay States, they took possession of the greater part of the world's supply of tin. There still remain the mines of Bolivia, but these can fulfill only a small part of the needs of the United States. While of great importance in many ways, tin in the form of the tin can used for the preservation of food, reaches every household. Some other method of food preservation is necessary if we are to reap the greatest benefit of the potential food supply of the United States. For more than a year one of the Regional Laboratories has been giving intensive consideration to the dehydration of vegetables with a view to producing an article which is not only palatable but which retains the flavor and vitamin characteristics of the original vegetable. This effort has been to a large extent successful, and it is now possible to obtain instruction sheets and plans for the erection of dehydrating apparatus which can be used for most varieties of vegetables. This slide on dehydratinn shows what I pointed out earlier in my talk, namely, that much of the research in these four large Laboratories is on a pilot plant or semicommercial plant scale.

Of course, these four Regional Research Laboratories were established primarily for the benefit of the farmers in the United States. But it is reasonable to assume that they may also indirectly be of service to agriculture in the other American Republics, because the agricultural problems in our country are often similar to those found in the countries to the south of us. For example, Argentina sometimes has a surplus of corn, just as we sometimes have it in the United States. Brazil produces cotton just as we do. Crops pay no attention to boundary lines, they grow wherever the soil and the climate and other necessary conditions are suitable. So what we in the United States would like to see would be the development of new uses and new and profitable markets and outlets for surplus crops wherever they may be found. That is what the Regional Laboratories are working to accomplish, and we hope that their results may be numerous and valuable, not only to the United States, but wherever they may have application in this hemisphere.